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CHAPTER EIGHT:

THICKNESS AND TONNAGE CONTROL

The thickness and width of the paving operation are shown on the typical sections in the contract plans or the proposal. The actual compacted thickness of the mat is required to conform to the planned design. The design thickness is determined so the pavement is strong enough to carry the anticipated traffic. If the mat is too thin, the pavement will likely fail prematurely. If the mat is too thick, the pay quantities will overrun and increase the cost of the contract unnecessarily.

The thickness of the mat is checked by verifying the uncompacted thickness behind the paver and by verifying the actual rate of spread.

The plans specify the rate in pounds per square yard that the HMA is to be placed. This is known as the "Planned Quantity". The planned quantity is used in checking the thickness and the rate of speed.

CHECKING THE MAT THICKNESS

DETERMINING MAT THICKNESS

Before performing any depth checks, the required thickness is required to be known. Through experience, HMA mixes have indicated that 110 pounds per square yard is equivalent to approximately one inch of compacted depth. Mixes made with slag aggregates weigh somewhat less or more depending on the type of slag used.

The formula for determining the compacted mat thickness is:

$$\frac{\text{Planned Quantity (lb/yd}^2\text{)}}{110 \text{ lb}} = \text{Desired mat thickness in inches}$$

Example 1:

$$\text{Planned quantity} = 330 \text{ lbs/yd}^2$$

$$\frac{330}{110} = 3.0 \text{ inches}$$

For a planned quantity of 330 lb/yd², the mat thickness would be approximately 3 inches.

Example 2:

Planned quantity = 90 lb/yd²

$$\frac{90}{110} = 0.818 \text{ inches or } \frac{13}{16} \text{ inches}$$

The mat thickness for 90 lb/yd² would be approximately 13/16 inches.

DEPTH CHECKS

The thickness of the uncompacted mat is checked immediately behind the paver screed and at various points across the lane. Depth checks should be made regularly and are useful in determining if particular areas on the grade or pavement differ greatly from the typical cross sections. An excessively thin or thick mat does not compact properly. A mat too thin drags the mix aggregate. A mat too thick is difficult to compact to the required density. Adjustments may need to be made to the paver for the depth of mix and the PE/PS informed of the problem. If the problem is extensive, the slope of the pavement or the planned thickness may need to be changed.

ACTUAL RATE OF SPREAD

The determination of the actual rate of spread is a more accurate method of determining the mixture placed than individual depth checks because the rate of spread considers the average spread over a longer paving length.

TECHNICIAN RESPONSIBILITY

Ensuring that the actual amount of mix placed by the Contractor complies with the plans is the responsibility of the HMA technician. The technician is required to collect weigh tickets as the mix is delivered to the paving site and keep a record of the actual amount of mix placed. This record allows the technician to determine the "Placed Quantity" and compare this quantity to the "Planned Quantity".

The technician is required to compute the actual rate of spread and compare this rate to the planned rate. The planned rate is typically shown on the plans in pounds per square yard. The actual rate of spread may be computed in pounds per linear foot, tons per linear foot, or pounds per square yard. Both the planned and actual rates are required to be in the same units for valid comparisons. The PE/PS should be consulted for the preferred method.

The purpose of computing the actual rate of spread is to determine if the planned amount is being placed. If the actual rate exceeds the planned rate, too much mix is being placed and there is an overrun of material. If the actual rate is less than the planned rate, too little mix is being placed and there is an underrun. In either case, adjustments are required to be made to bring the actual quantity in line with the planned quantity.

STATIONING

Highway contracts are surveyed and staked in 100 foot increments called stations. Station 1 is written as 1+00, Station 25 as 25+00, and so on. Station 25+00 would equal 2500 feet from a fixed reference point.

The use of stations makes the determination of distance paved relatively easy. If the paving started at Station 25+00 and ended at Station 60+00, there would be 3500 feet (6000 minus 2500) of mix paved. To be more precise, the distance from the actual starting or ending point to a station is determined and added or subtracted from the station referenced. For example, if the paving started 75 feet past Station 25+00, the starting point would be 25+75, or 2575 feet from the fixed reference point. If the ending point was forty feet beyond Station 60+00, or 60+40, the distance paved would be 6040 minus 2575 or 3465 feet.

WEIGH TICKETS

A weigh ticket which shows the net weight of the material is required to be furnished for every load of mix delivered to the paving site. The weigh ticket is issued to the truck driver at the weighing site and is required to be signed by the INDOT Weighman supervising the Contractor's weighing operations. However, when the Contractor is using computerized scales there is not a requirement for a weighman and the tickets are delivered to the contract unsigned. When daily totals of mix are predicted to be above 1000 tons, one load for each 1000 tons is required to be verified by an independent approved scale.

The HMA technician is required to collect a weigh ticket for each load from the truck driver at the same time the material is unloaded at the paving site. Upon taking the ticket, the technician should:

- 1) Check the ticket for the INDOT Weighman's signature (if required) verifying that the information is correct
- 2) Write on the ticket the starting station of the load and the lane (right, left, or center) where the material is placed. A preferred method of designating lanes is EBPL (eastbound passing lane), EBDL (eastbound driving lane), etc.

- 3) Keep a running total of the mix unloaded at the paving site on the back of the ticket
- 4) Sign the original ticket after checking the appearance of the mix

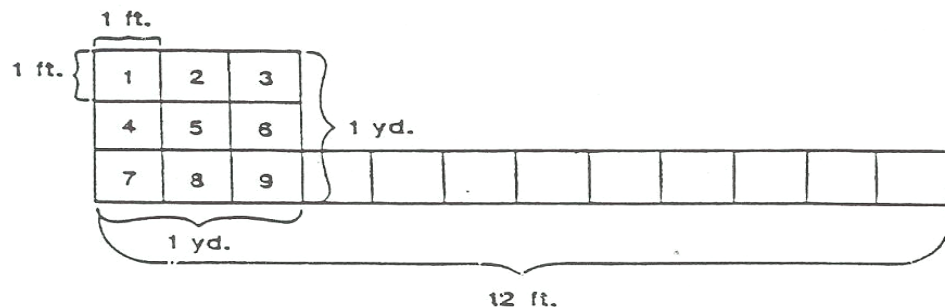
At any time during the day and at any point along the roadway, the number of tons of mix that has been dumped into the paver should be known.

COMPUTING RATES OF SPREAD

As stated above, there are several methods of computing the actual rate of spread. The calculations differ primarily in the units in which the rates are expressed. The three methods are:

- 1) Method 1 – rate expressed in pounds per square yard
- 2) Method 2 – rate expressed in pounds per linear foot
- 3) Method 3 – rate expressed in tons per linear foot

Before starting the explanations of the rates of spread, the relationships between the areas of the three methods is required. As shown in the diagram below, 9 square feet equals 1 square yard. The number of square yards in a linear foot depends on the width being paved.



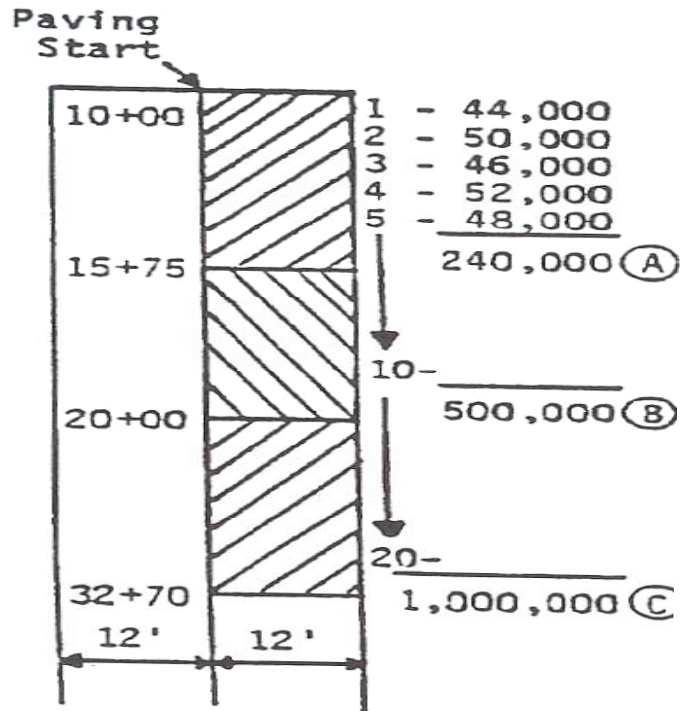
The formula for determining the relationship is:

$$\frac{1 \text{ foot} \times \text{pavement width (feet)}}{9 \text{ ft}^2/\text{yd}^2} = \frac{1 \times w}{9} = \text{yd}^2/\text{lft (linear foot)}$$

For a width of 12 feet as shown in the above diagram, the square yards per linear foot would be:

$$\frac{1 \times 12}{9} = 1.33 \text{ yd}^2/\text{lft}$$

Examples of the three methods of checking the actual rates with planned rates are as follows. The diagram below indicating the amount paved and quantities used applies to all three examples.



Method 1 – Pounds per Square Yard

The planned quantity is 330 lb/yd². The procedure for the first 5 loads is as follows:

- 1) Total the weights of the loads placed in pounds to the point where the check is made. The total of the first five loads equals 240,000 pounds.
- 2) Determine the total length paved in linear feet.
Loads 1 through 5 began at Station 10+00 and end at Station 15+75

$$(15+75) - (10+00) = 575 \text{ lft}$$

- 3) Determine the area paved in square yards.

$$\frac{\text{Total length} \times \text{width paved}}{9} = \frac{575 \times 12}{9} = 767 \text{ yd}^2$$

- 4) Calculate the actual rate of spread in lb/yd²

$$\frac{\text{Total mix placed (lb)}}{\text{Area paved (yd}^2\text{)}} = \frac{240,000 \text{ lb}}{767 \text{ yd}^2} = 312.9 \text{ lb/yd}^2$$

- 5) Compare the placed quantity and planned quantity

If placed quantity = planned quantity: Mat is correct

If placed quantity > planned quantity: Overrun

If placed quantity < planned quantity: Underrun

The planned quantity equals 330 lb/yd². The placed quantity of 312.9 lb/yd² is less than the planned quantity indicating an underrun and a mat that is too thin. The Contractor is required to make the necessary adjustments.

After load 10, the paver is at Station 20+00 and 500,000 pounds have been placed.

$$\text{Total length} = (20+00) - (10+00) = 1000 \text{ lft}$$

$$\text{Area} = (1000 \times 12) / 9 = 1333 \text{ yd}^2$$

$$\text{Placed Quantity} = 500,000 / 1333 = 375 \text{ lb /yd}^2$$

The placed quantity of 375 lb/yd² is greater than the planned quantity indicating an overrun.

After Load 20, the paver is at Station 32+70 and a total of 1,000,000 lb have been placed.

$$\text{Total length} = (32+70) - (10+00) = 2270 \text{ lft}$$

$$\text{Area} = (2270 \times 12) / 9 = 3027 \text{ yd}^2$$

$$\text{Placed quantity} = 1,000,000 / 3027 = 330.4 \text{ lb/yd}^2$$

The placed quantity equals the planned quantity indicating the spread rate is correct.

Method 2 – Pounds per Linear Foot

The planned quantity is 330 lb/yd²

- 1) Convert the planned quantity from lb/yd² to lb/lft

$$\frac{\text{length of one foot} \times \text{width paved}}{9 \text{ ft}^2/\text{yd}^2} = \frac{1 \times 12}{9} = 1.33 \text{ yd}^2/\text{lft}$$

$$\text{planned quantity} \times \text{yd}^2/\text{lft} = 330 \times 1.33 = 440 \text{ lb/lft}$$

- 2) Total the weights of the loads placed in pounds to the point where the check is made.

The total of the first five loads equals 240,000 pounds

- 3) Determine the total length paved in linear feet

Loads 1 through 5 began at Station 10+00 and end at Station 15+75

$$(15+75) - (10+00) = 575 \text{ lft}$$

- 4) Calculate the actual rate of spread in lb/lft

$$\frac{\text{total mix placed}}{\text{total length paved}} = \frac{240,000 \text{ lb}}{575 \text{ lft}} = 417.4 \text{ lb/lft}$$

- 5) Compare the placed quantity and the planned quantity

The placed quantity of 417.4 lb/lft is less than the planned quantity of 440 lb/lft indicating that an underrun and a mat that is too thin.

After Load 10, the paver is at Station 20+00 and 500,000 pounds have been placed.

$$\begin{aligned} \text{Total length} &= (20+00) - (10+00) = 1,000 \text{ lft} \\ \text{Placed quantity} &= 500,000 / 1,000 = 500 \text{ lb/lft} \end{aligned}$$

The placed quantity of 500 lb/lft is greater than the planned quantity of 440 lb/lft indicating an overrun and a mat that is too thick.

After Load 20, the paver is at Station 32+70 and 1,000,000 lb have been placed.

$$\begin{aligned} \text{Total length} &= (32+70) - (10+00) = 2270 \text{ lft} \\ \text{Placed quantity} &= 1,000,000 / 2270 = 440.5 \text{ lb/lft} \end{aligned}$$

The placed quantity equals the planned quantity indicating that the spread rate is correct.

Method 3 – Tons per Linear Foot

The planned quantity is 330 lb/yd²

- 1) Convert the planned quantity from lb/yd² to t/lft

$$\frac{\text{planned quantity (lb/yd}^2\text{)} \times \text{width of paving (ft)}}{9 \text{ (ft}^2\text{/yd}^2\text{)} \times 2000 \text{ (lb/t)}} = \frac{330 \times 12}{18,000} = 0.22 \text{ t/lft}$$

- 2) Total the weights of the loads placed in pounds to the point where the check is made and convert to tons.

The total of the first five loads equals 240,000 pounds.

Note: 2,000 pounds equals 1 ton.

$$\frac{\text{pounds placed}}{2000 \text{ lb}} = \frac{240,000}{2,000} = 120 \text{ tons}$$

- 3) Determine the total length paved in linear feet.

Loads 1 through 5 began at Station 10+00 and end at Station 15+75

$$(15+75) - (10+00) = 575 \text{ lft}$$

- 4) Calculate the theoretical quantity (tons) for the total length paved.

$$\text{planned quantity (tons/lft)} \times \text{total length paved (lft)}$$

$$0.22 \text{ tons/lft} \times 575 \text{ lft} = 126.5 \text{ tons}$$

- 5) Compare the placed quantity and theoretical quantity

$$\text{placed quantity} - \text{theoretical quantity} = \text{tons over/under}$$

$$120 \text{ tons} - 126.5 \text{ tons} = -6.5 \text{ tons (Underrun)}$$

Note: If net tons is positive, there is an overrun

If net tons are negative, there is an underrun

- 6) Calculate % of underrun or overrun

$$\frac{\text{net over/under (tons)}}{\text{theoretical quantity (tons)}} \times 100 = \frac{-6.5}{126.5} \times 100 = 5.14\% \text{ underrun}$$

PAVING REPORT

The quantity checks made by the HMA technician using the method designated by the PE/PS are required to be documented.